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RD INSTRUMENTS

FOR RESEARCH AND DEVELOPMENT

INSTRUCTION MANUAL

for

MODEL 385

OSCILLOSCOPE

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THE HICKOK ELECTRICAL INSTRUMENT COMPANY · 10514 Dupont Avenue, Cleveland 8, Ohio

OPERATING INSTRUCTIONS

for

MODEL 385

OSCILLOSCOPE

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TECHNICAL DATA

MODEL 385 LIGHT WEIGHT SMALLER SIZE PORTABLE OSCILLOSCOPE:

FREQUENCY RANGE:

a. Vertical Amplifier:

1. DC to 4 MC with Band Width Switch in Wide position for color burst observation.

2. DC to 2 MC, 3db down, with Band Width Switch in 2MC position for pulse observation. This 2 MC response is in accordance with the I.R.E., standard roll-off specification for television level setting.

b. Horizontal Amplifier: DC to 500 KC, 3db down.

c. Sweep Circuit Oscillator: 3 cycles to 50 KC.

INPUT IMPEDENCE:

a. Vertical Amplifier: 2.2 Megohms - 25 MMF.

b. Horizontal Amplifier: 2.2 Megohms - 25 MMF.

DEFLECTION SENSITIVITY:

a. Vertical Amplifier: .075 RMS Volts/Inch.

b. Horizontal Amplifier: .075 RMS Volts/Inch.

SPECIAL FEATURES:

a. Laboratory quality portable in a new handier size with a 3" screen.

b. Ideal for observation of Color Burst at 3.58 MC.

c. Telescopic light shield for higher accuracy.

d. Replaceable circuit sections.

DIMENSIONS: 5½" Wide x 8" high x 13¼" deep. 11 lbs. Net. 105-125 Volts, 50-1,000 cycles, 60 Watts.

Also available with strong aluminum water-proof, moisture-proof, shock mounted carrying case.

DIMENSIONS: 6" wide x 9" high x 12½" deep. 15 lbs. Net.

MODEL 385R 3" OSCILLOSCOPE FOR RACK MOUNTING:

Same specifications and features as the Model 385.

DIMENSIONS: 19" wide x 5¼" high x 9¼" deep. 15 lbs. Net.
105-125 Volts, 50-1,000 cycles, 60 Watts.

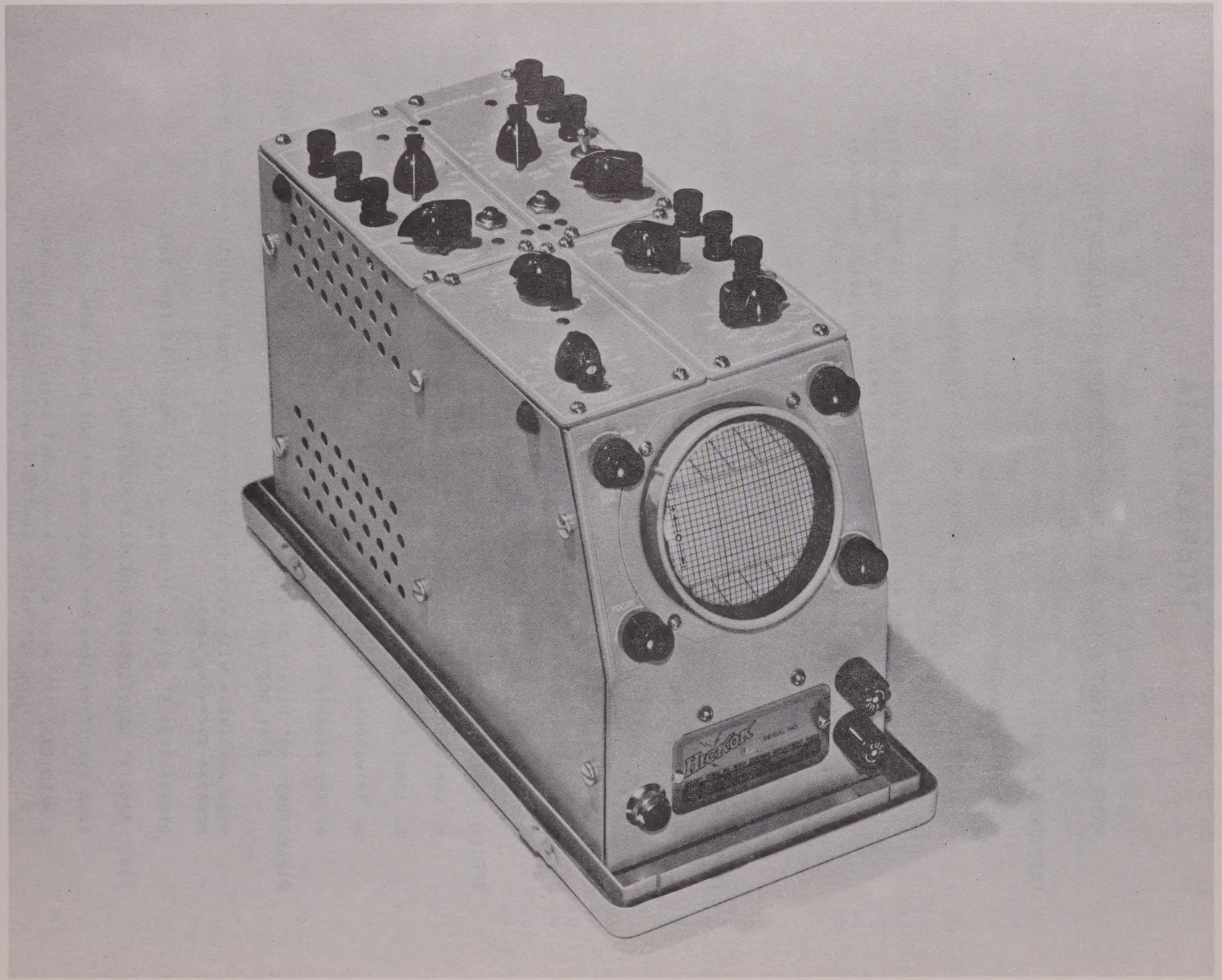

FIGURE 1. MODEL 385 OSCILLOSCOPE

SECTION I

GENERAL DESCRIPTION

1. PURPOSE

This instruction book describes Oscilloscope 385 and includes information concerning the operation and maintenance of the equipment.

2. BRIEF DESCRIPTION

The Model 385 has been designed to provide a choice of 2 vertical bandwidths. The "2 mc." bandwidth is provided for general purpose use with accent on good pulse response. This response has a roll-off in accordance with the I.R.E. standard for television level setting. The "WIDE" bandwidth response is flat beyond the color burst frequency of 3.58 mc and is specifically designed to be used for color burst observations, however, because of the more stringent high frequency requirements when used with this wide response, it is recommended the useful screen height be limited to 1-1/2 inches.

This oscilloscope operates from 115 volts ±10%, 50-1000 cycles a-c-, and is designed to be used as a visual testing instrument in all instances where such apparatus can be used to service electronic equipment. It has been designed to be as small and light in weight as possible, consistent with its ability to perform the functions required of it. Some of the characteristics of this oscilloscope which make it a useful instrument are: vertical d-c amplifier operating over a frequency range of zero cycles to 4 megacycles per second, independent of gain control setting, with a sensitivity of .075 RMS volts per inch; horizontal d-c amplifier operating over a frequency range of zero cycle to 500,000 cycles per second, independent of gain control setting, with a sensitivity of .075 RMS volts per inch; self-contained sweep circuit oscillator operating through a frequency range of 3 to 50,000 cycles per second with provisions for synchronizing of either positive or negative synchronizing voltages; provisions for beam blanking from either internal or external sources; direct access to both horizontal and vertical deflecting plates; (In order to reach the stringent frequency response of the vertical amplifier, the direct connection has been eliminated. The provisions, however, are on the direct connection board for use in special applications with a slight wiring modification,) shock mounted within a watertight carrying case; and of unitized construction throughout to allow for versatility and ease of servicing. In regard to this last characteristic, the oscilloscope is made up of seven major assemblies: vertical amplifier, horizontal amplifier, sweep circuit oscillator, sync. circuit, power supply, cathode ray tube assembly, and potentiometer assembly (comprised of vertical positioning, horizontal positioning, intensity and focus controls). Each of these assemblies is interchangeable from one oscilloscope to another, thus allowing for consolidation of working assemblies in case of emergency.

The portable construction of this oscilloscope makes it convenient to carry to any location where visual servicing is required. This oscilloscope is capable of any number of operations within its ratings, including alignment and testing of electronic and electrical equipment, hum measurements, frequency comparison, observance of complex waveforms, percentage modulation measurements, etc. Operators should familiarize themselves with each control by obtaining a pattern and then rotating the control and noting the effect, except for intensity which should not be allowed to be of extreme brilliance.

3. SPECIFICATIONS:

A. FREQUENCY RANGE:

(1) Vertical Amplifiers:

(a) 0-2,000,000 cycles, ± 3 DB, independent of gain control setting in 2 MC position.

(b) 0-4,000,000 cycles, ±3 DB, independent of gain control setting in WIDE position.

(2) Horizontal Amplifier:

(a) 0-500,000 cycles, ±3 DB, independent of gain control setting.

(3) Sweep Circuit Oscillator: 3 to 50,000 cycles.

B. POWER REQUIREMENTS: 105-125 volts, 50-1000 cycles, a-c, single phase, 60 watts at 115 volts.

C. INPUT IMPEDANCE:

(1) Vertical: 2.2 megohm shunted by 25 mmf.

(2) Horizontal: 2.2 megohm shunted by 25 mmf.

(3) Vertical Direct: 9 megohms shunted by 11 mmf. (In order to reach the stringent frequency response of the vertical amplifiers, the direct connection has been eliminated. The provisions, however, are on the direct connection board for use in special applications with a slight wiring modification.)

(4) Horizontal Direct: 9 megohms shunted by 11 mmf.

D. DEFLECTION SENSITIVITY:

(1) Vertical: Amplifier - .075 RMS volts/inch. Direct - approximately 17 RMS volts/inch. (In order to reach the stringent frequency response of the vertical amplifier, the direct connection has been eliminated. The provisions, however, are on the direct connection board for use in special applications with a slight wiring modification.)

(2) Horizontal: Amplifier - .075 RMS volts/inch. Direct - approximately 25 RMS volts/inch.

4. EQUIPMENT DATA

TABLE 1-1. EQUIPMENT SUPPLIED

QUANTITY PER EQUIPMENT	NAME OF UNIT
1	Oscilloscope
1	Case (when ordered with case)
1	Test Lead
1	Ground Lead
1	Cathode Ray Tube Screen
1	Instruction Book

5. TUBE COMPLEMENT

TABLE 1-2. TUBE COMPLEMENT

TUBE	TYPE	FUNCTION
V101A-V101B	12AT7	Vert. Cathode Follower
V102A-V102B	12AT7	1st Vert. DC Amplifier
V103	6AH6	2nd Vert. DC Amplifier
V104	6AH6	2nd Vert. DC Amplifier
V105A-V105B	12AT7	Horiz. Cathode Follower
V106A-V106B	12AT7	1st Horiz. DC Amplifier
V107A-V107B	6J6	2nd Horiz. DC Amplifier
V108A-V108B	6J6	Sweep Circuit Oscillator
V109A-V109B	12AT7	Sync. Amplifier-Intensity Mod. Amp.
V110	6X4	Intermediate Voltage Rectifier
V111	3RP1	Cathode Ray Tube
CR101	Selenium	Low Voltage Rectifier
CR102	Selenium	Low Voltage Rectifier
CR103	Selenium	High Voltage Rectifier

SECTION 2
CIRCUIT DESCRIPTION

I. GENERAL

During the following discussion, reference to the block diagram of the oscilloscope, Figure 2-1, and the schematic wiring diagram, Figure 4-2, will facilitate the understanding of the basic operation of the circuits used in this equipment.

A. VERTICAL AMPLIFIER

(1) Vert. Atten. and Vert. Gain

Voltages applied to the vertical AC or DC input may be attenuated by a factor of 1, 10, or 100 by means of the VERT. ATTEN. control and further controlled by the position of the VERT. GAIN control. With the VERT. ATTEN. in the CAL. position, a line frequency calibration voltage of 0.5 volts peak to peak is applied to the vertical amplifier for use in conjunction with the VERT. GAIN control in calibrating the deflection sensitivity of the amplifier.

(2) Cathode Follower and D. C. Bal.

A type 12AT7 tube, V101A-V101B is used as a cathode follower to provide for high impedance vertical input. The output voltages from this stage are taken from the low impedance cathode circuits and attenuated with a low impedance gain control before being applied to the following DC amplifier stage.

The D. C. BAL. control is used to equalize the two cathodes so that there is no vertical shift in beam positioning with the operation of the VERT. GAIN control.

(3) Amplifiers

The vertical amplifiers consisting of one 12AT7, V102, and two 6AH6's, V103 and V104, connected in push-pull cascade are of the direct-coupled type and serve for amplification of both AC and DC voltages. The high frequency range of these amplifiers is 2MC in the 2MC position and 4MC in the wide position.

B. HORIZONTAL AMPLIFIER

(1) Hor. Atten. and Hor. Gain

Voltages applied to the horizontal AC or DC input may be attenuated by a factor of 1, 10 or 100 by means of the HOR. ATTEN. switch and further controlled by the HOR. GAIN control. With the HOR. ATTEN. in the CAL. position, a line frequency calibration voltage of 0.5 volts peak to peak is applied to the horizontal amplifier for use in conjunction with the HOR. GAIN control in calibrating the deflection sensitivity of the amplifier. With the HOR. ATTEN. control in the SWEEP position, the sawtooth output from the sweep circuit oscillator is applied to the horizontal amplifier through the horizontal cathode follower and the sweep width may be controlled by the position of the HOR. GAIN control.

(2) Cathode Follower and D. C. Bal.

A type 12AT7 tube, V105A-V105B, is used as a cathode follower to provide for high impedance horizontal input. The output voltages from this stage are taken from the low impedance cathode circuits and attenuated with a low impedance gain control before being applied to the following DC amplifier stage. The D. C. BAL. control is used to equalize the two cathodes so there is no horizontal shift in beam positioning with the operation of the HOR. GAIN control.

(3) Amplifiers

The horizontal amplifiers consisting of a 12AT7, V106, and a 6J6, V107, connected in push-pull cascade are of the direct-coupled type and serve for the amplification of both AC and DC voltages. The high frequency range of these amplifiers is 500,000 cycles. When the horizontal amplifiers are being used to amplify the internal sawtooth they are fed through the cathode follower, V105, in the same manner as an external AC voltage.

C. SWEEP CIRCUIT OSCILLATOR

A type 6J6 tube, V108, is used in a multivibrator type circuit to generate linear sawtooth voltages for horizontal deflection of the cathode ray tube. Six positions of the COARSE FREQUENCY control are used in conjunction with a two-gang potentiometer, R172A and R172B to provide control of sawtooth frequencies between 3 and 50,000 cycles.

D. SYNC. SELECTOR and AMPLIFIER

A three-position SYNC. SELECTOR switch, S103, is used as a means to provide a selection of EXT., INT. or LINE frequencies to be used in connection with synchronizing the sweep circuit oscillator.

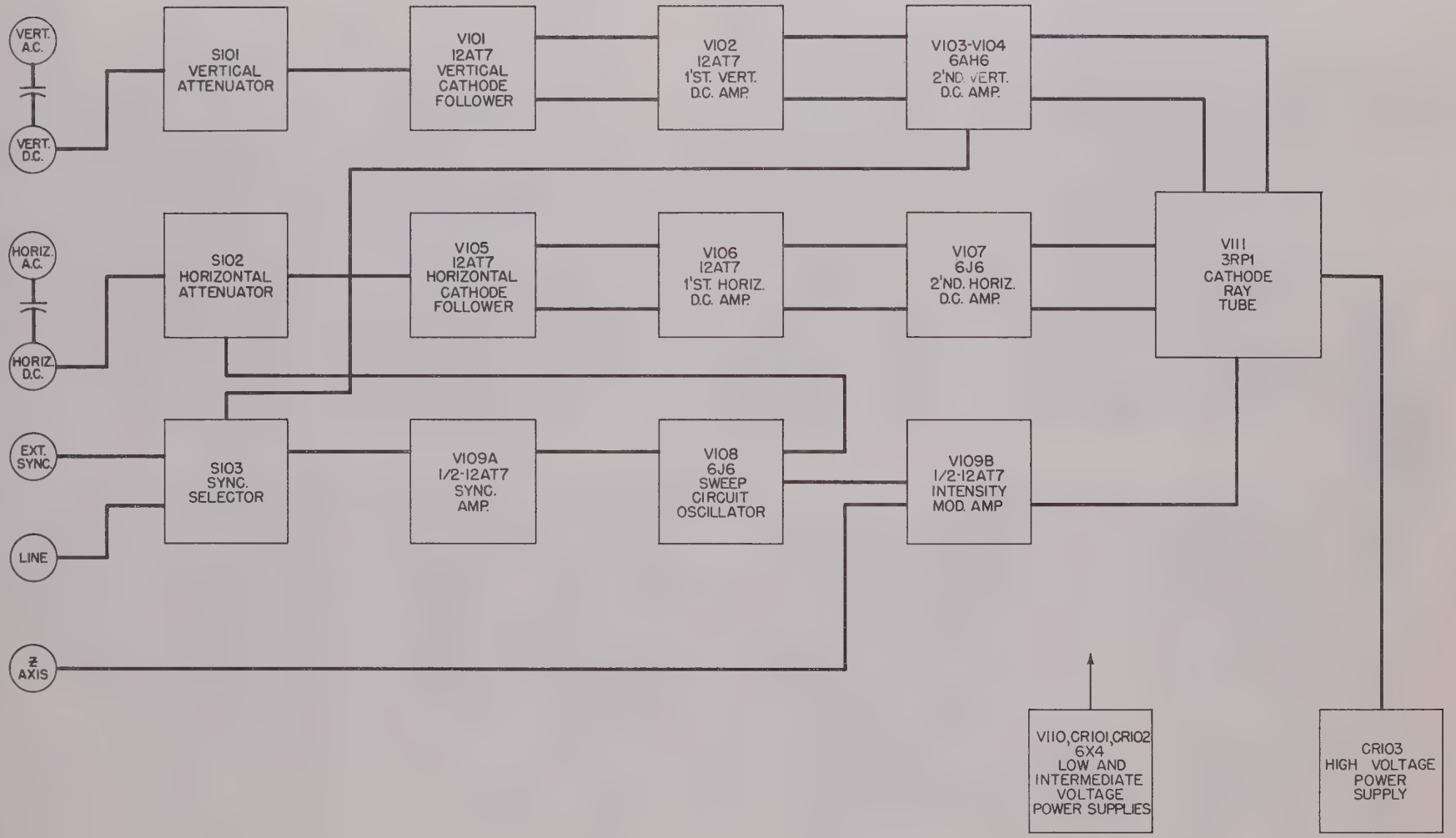
VERT. A.C.
VERT. D.C.
S101 VERTICAL ATTENUATOR
V101 12AT7 VERTICAL CATHODE FOLLOWER
V102 12AT7 1'ST. VERT. D.C. AMP.
V103-V104 6AH6 2'ND. VERT. D.C. AMP.
HORIZ. A.C.
HORIZ. D.C.
S102 HORIZONTAL ATTENUATOR
V105 12AT7 HORIZONTAL CATHODE FOLLOWER
V106 12AT7 1'ST. HORIZ. D.C. AMP.
V107 6J6 2'ND. HORIZ. D.C. AMP.
V111 3RP1 CATHODE RAY TUBE
EXT. SYNC.
LINE
S103 SYNC. SELECTOR
V109A 1/2-12AT7 SYNC. AMP.
V108 6J6 SWEEP CIRCUIT OSCILLATOR
V109B 1/2-12AT7 INTENSITY MOD. AMP
Z AXIS
V110, CR101, CR102 6X4 LOW AND INTERMEDIATE VOLTAGE POWER SUPPLIES
CR103 HIGH VOLTAGE POWER SUPPLY

Figure 2-1. Basic Circuits in Block Form

Voltages selected by the SYNC. SELECTOR are fed to the control grid of one-half of the 12AT7 tube, V109A. The LOCKING control, R166, is so connected that it permits synchronization of the sweep circuit oscillator on either positive or negative peaks of the selected synchronizing voltage.

E. INTENSITY MODULATION AMPLIFIER.

One-half of a type 12AT7 tube, V109B, is used as an amplifier whereby external or internal voltages may be amplified to provide for intensity modulation of the beam of the cathode ray tube. By connecting a jumper between BLANKING terminals on terminal board E110, pulses from the sweep circuit oscillator may be used to blank out the return trace when using horizontal sweep.

F. CATHODE RAY TUBE.

A type 3RP1 electrostatic deflection cathode ray tube, V111, is used as the indicating medium. Deflection voltages for this tube may be applied from internal circuits, or by rearranging the jumpers on terminal board E110 external voltages may be directly applied for deflection.

G. POWER SUPPLY

A type 6X4 tube, V110, is connected as a full-wave rectifier and supplies DC voltages for operation of the cathode followers, final amplifier stages and sweep circuit oscillator. A pair of selenium rectifiers, CR101 and CR102, are connected as a full-wave rectifier and supply low DC voltages for the operation of all the other circuits except the cathode ray tube. A selenium rectifier, CR103, is connected as a half-wave rectifier to supply the high voltage for the cathode ray tube. Suitable other windings are on the power transformer, T101, to supply the heater voltages for all tubes in the instrument. The transformer is fused by means of fuses F101 and F102 located on the front panel.

2. CIRCUIT ANALYSIS

A. VERTICAL AMPLIFIER

(1) Vertical Input Attenuator.

AC or DC voltages impressed between the vertical input (AC or DC) and GND are applied to the three-stage vertical attenuator network. This network consists of resistors R102 and R103 shunted by C102 and C103 respectively, and resistors R102 and R105 by C104 and C105. The network is so designed that it is non-frequency discriminating to square wave frequencies of 100 kc. On position "1" the voltage impressed is applied to grid pin 7 of the vertical cathode follower, V101B. On position "10" this voltage is reduced by a factor of ten, and on position "100" the voltage is reduced by a factor of 100. When the VERT. ATTEN., S101, is operated to the CAL position, a line frequency calibration signal of 0.5 volts is applied to grid pin 7 of the vertical cathode follower, V101B from the calibration voltage adjustment potentiometer R106.

(2) Cathode Follower.

A 12AT7 tube, V101A-V101B, is connected in a conventional push pull cathode follower circuit with plate bypassed to ground by C141A and C106. Any voltage applied between the grids will, in the same phase, at a slightly lower potential, appear between the cathodes. These cathodes are directly coupled to the grids, pins 2 & 7, of the first vertical DC amplifier, V102A-V102B. One side of this cathode follower circuit handles the single ended input signal while the other side is at a zero signal level. The gain is controlled by shorting the cathodes together with a shorting type GAIN control R116. The DC voltage on the two cathodes is equalized by the use of the DC BAL control, R111, so there is no shift in the vertical position of the trace as the GAIN control is rotated.

(3) Vertical Amplifier Stages

The vertical amplifiers are of the direct-coupled push-pull type. This allows the amplification of DC as well as AC voltages. The fact that the amplifiers are push-pull affords excellent stability with line voltage variations. The signal is fed to the grids (pins 2 & 7) of the first DC amplifier, V102A-V102B, via the direct coupling from the cathodes of the push-pull cathode follower stage. The cathode bias for this stage is developed in the network consisting of the common cathode resistors, R117 and R118, which provide phase inversion and the vertical positioning control, R119, shunted by R120. The B+ voltage is supplied to the plates of this amplifier through the plate load resistors, R121 and R122.

The output from this first push-pull amplifier is applied between the grids, pins 1 of V103 and V104, which comprise the second push-pull amplifier, through resistors R123 and R124. These resistors act to suppress any tendency for spurious

oscillation. The cathodes of V103 and V104 are tied together and biased to ground through resistor R126 and BIAS ADJUST, R125. Since the grids of V103 and V104 are approximately 80 volts above ground, because of the direct connection from the previous stage, the cathode must develop a voltage slightly higher than this to supply sufficient operating bias. The B+ voltage is supplied to the plates, pins 5 of V103 and V104, through plate load resistors R130 and R131 and the wide band peaking network consisting of R132 and R133 and L101 and L102. The screen grids, pins 6 of V103 and V104, are tied together and supplied with voltage through a common screen dropping resistor, R128 in series with LINEARITY control, R129. Since these tubes are operating in push-pull, there is no need for bypass on these screens. The suppressor grids, pins 2 of V103 and V104, are tied to the cathode as in normal pentode connection when the cathode is operated above ground. The signal is directly coupled from the plates, Pins 5, of the final push-pull amplifier stage, to the deflection plates of the cathode ray tube.

Since the circuit is designed in push-pull, any B+ variation caused by fluctuating line voltages has essentially no effect on the centering of the beam of the cathode ray tube, as a voltage change on one plate is accompanied by an equal voltage change on the other plate. The path of the signal is through one side of the push-pull cathode follower, V101B, and on to the grid, Pin 7, of V102B. It is then transferred to V102A through the common cathode resistance R117 and R118. The action is as follows: As a positive signal appears on grid pin 7 of V102B, this tube draws more current. As the current increases, the voltage at cathode pin 8 will rise. This rise is carried to cathode pin 3 of V102A by virtue of the common cathode connection. Since grid pin 2 of V102A is at a stationary potential as far as the signal is concerned, the rising cathode voltage causes this tube to draw less current, accomplishing a push-pull double-ended output between the plates, pins 1 and 6 of V102A and V102B.

Phase inversion is not completed in this stage, however, the action described above is repeated in the final stage, V103 and V104, and the resulting output is double-ended.

At high frequencies a portion of the signal on the plate of V103 is fed to grid pin 1 of V104 through trimmer condenser C110. Trimmer condenser C110 is adjusted to give the amplifier sufficiently high frequency response in the 2 mc band width position of the bandwidth switch. When the bandwidth switch is in the wide band position, a resistive-inductive network (R132-L101, R133-L102) is introduced at the bottom of each of the final amplifier plate load resistors, R130 and R131. The high frequencies developed across these networks are coupled back to the front of the amplifier (cathodes pins 3 and 8 of V102) through trimmer condensers C108 and C109. These trimmer condensers are adjusted to give the amplifier sufficient high frequency response in the wide bandwidth position of the bandwidth switch.

BIAS ADJUST R125 is provided so that tolerances in resistors and electron tubes may be accounted for in providing the proper bias on the final stage. A LINEARITY adjustment, R129, is incorporated in the circuit to adjust the voltage on the screens of the final push-pull stage (V103 and V104) in order to accomplish maximum linearity with changes in tubes. Normally, these controls will not have to be adjusted unless tubes V102, V103 and V104 are changed, in which case the adjustments will be minor.

B. HORIZONTAL AMPLIFIER

(1) HORIZONTAL INPUT ATTENUATOR.

Voltages impressed between the horizontal AC or DC input and GND are applied to the three-stage horizontal attenuator network. This network consists of resistors R136 and R137 shunted by C114 and C115 respectively and resistors R138 and R139 shunted by C116 and C117. The network is so designed that it is non-frequency discriminating up to the square wave frequency of 25 kc. On position "1" the voltage impressed is applied directly to grid pin 2 of the horizontal cathode follower, V105A. On position "10" this voltage is reduced by a factor of ten, and on position "100" the voltage is reduced by a factor of 100. When the HOR. ATTEN., S102, is operated to the CAL position, a line frequency calibration signal of 0.5 volts is applied to grid pin 2, of the horizontal cathode follower, V105A, from the calibration voltage adjustment potentiometer, R106. When the HOR. ATTEN., S102, is operated to the "SWEEP" position, the internal sawtooth voltage is fed to grid, pin 2, of the horizontal cathode follower, V105A, shunted by the resistor-capacitor combination R134 and C113.

(2) HORIZONTAL CATHODE FOLLOWER.

A 12AT7 tube, V105A, is connected in the conventional push pull cathode follow-

er circuit with plate bypassed to ground by C141 and C118. Any voltage applied between the grids will, in the same phase, at a slightly lower potential, appear between the cathodes. These cathodes are directly coupled to the grids, pins 2 and 7, of the first horizontal DC amplifier, V106A-V106B. One side of this cathode follower circuit handles the single-ended input signal while the other side is at a zero signal level. The gain is controlled by shorting the cathodes together with a shorting type GAIN control R146. The D.C. voltage on the two cathodes is equalized by the use of the DC BAL control R145 so there is no shift in the horizontal position of the trace as the GAIN control is rotated.

(3) HORIZONTAL AMPLIFIER STAGES.

The horizontal amplifiers are of the direct-coupled push-pull type. This allows the amplification of DC as well as AC voltages. The fact that the amplifiers are push-pull affords excellent stability with line voltage variations. The signal is fed to the grids, pins 2 and 7, of the first DC amplifier, V106A-V106B, via the direct coupling from the cathodes of the push-pull cathode follower stage. The cathode bias for this stage is developed in the common cathode resistor, R149. This common cathode resistor provides partial phase inversion, the rest being taken care of in the final stage. The B+ voltage is supplied to the plates of this amplifier through the plate load resistors, R150 and R151, and the positioning potentiometer, R152.

The output from this first-push-pull amplifier is applied between the grids, pins 5 and 6 of V107, which comprises the second push-pull amplifier, through resistors R153 and R154. These resistors act to suppress any tendency for spurious oscillation. The cathode of V107 is biased to ground through resistor R156 and BIAS ADJUST, R155. Since the grids of V107 are approximately 60 volts above ground, because of the direct connection from the previous stage, the cathode must develop a voltage slightly higher than this to supply sufficient operating bias. The B+ voltage is supplied to the plates, pins 1 and 2 of V107, through plate load resistors R157 and R158. The signal is directly coupled from these plates to the deflection plates of the cathode ray tube through terminal board E110.

Since the circuit is designed in push-pull, any B+ variation caused by fluctuating line voltage has essentially no effect on the center of the beam of the cathode ray tube, as a voltage change on one plate is accompanied by an equal voltage change on the other plate. The path of the signal is through one side of the push-pull cathode follower, V105A, and on to the grid, pin 2 of V106A. It is then transferred to V106B through the common cathode resistance R149. The action is as follows: As a positive signal appears on grid pin 2 of V106A, this tube draws more current. As the current increases, the voltage at cathode pins 3 and 8 will rise. Since grid pin 7 of V106B is at a stationary potential so far as the signal is concerned, the rising cathode voltage causes V107B to draw less current, accomplishing a push-pull double-ended output between the plates, pins 1 and 6 of V106.

Phase inversion is not completed in this stage, however, the action described above is repeated in the final stage, V107, and the resulting output is double-ended.

At high frequencies a portion of the signal on the plate of V107B is fed to grid pin 6 of V107A through trimmer condenser C119. This high frequency signal boosts the high frequency output. Trimmer condenser C119 is adjusted to give the amplifier sufficiently high frequency response. BIAS ADJUST R155 is provided so that tolerances in resistors and electron tubes may be accounted for in providing the proper bias on the final stage. Normally, these controls will not have to be adjusted unless tubes V106 and V107 are changed, in which case the adjustments will be minor.

C. SWEEP CIRCUIT OSCILLATOR

A cathode coupled multivibrator circuit utilizing a type 6J6 tube, V108, is used as the horizontal sawtooth oscillator and operated over a frequency range from 3 to 50,000 cycles per second. This range of frequencies is controlled by the COARSE FREQUENCY switch, S104, utilizing capacitors C123 through C129. These capacitors act alternately and respectively as sawtooth generating capacitors for the second triode section V108B, and as coupling capacitors for the first triode section, V108A, to the second triode section of the multivibrator.

Fine frequency control is accomplished by means of the dual VERNIER FREQUENCY potentiometer, R172A and R172B, in the plate circuit and in the grid of the second triode section of the multivibrator. Both potentiometers are on the same shaft and operated by the VERNIER FREQUENCY control on the SWEEP CIRCUIT OSCILLATOR panel.

The sawtooth output is taken from plate pin 1 of V108B through the frequency compensated voltage divider consisting of R175 shunted by C130 and C131 and R134 shunted by C113, and decoupled by capacitor C132. This sawtooth signal is applied to the horizontal cathode follower through HOR. ATTEN. S102 when set to the "SWEEP" position. The high frequency linearity of the sawtooth may be adjusted with capacitor C130 in the frequency compensated dividing network.

Bias for the multivibrator is supplied by cathode resistor R169. The wave form at the cathode consists of sharp pulses of the exact width of the retrace time and in the proper phase. These pulses may be jumpered at terminal board E110 to the input of the intensity modulation amplifier and thus provide return trace elimination when using the sweep circuit oscillator. The synchronizing signal from the LOCKING control, R166, is applied to grid pin 5 of V108A through isolation resistor, R167. This causes the frequency of the multivibrator to lock in at the frequency of the synchronizing signal or some submultiple thereof.

D. SYNC. SELECTOR--AMPLIFIER

The purpose of the SYNC. SELECTOR switch, S103, and amplifier is to provide a means of synchronizing the sweep circuit oscillator from either EXT., INT. or LINE frequency voltages and to permit the synchronization of the sweep circuit oscillator from either positive or negative peaks of the applied synchronizing voltage. The output from the SYNC. SELECTOR is fed through capacitor C121 to grid, pin 7, of V109A and selects either:

(1) line frequency voltage supplied from the filament winding through a voltage divider consisting of R160 and R161,

(2) external frequency voltage applied to binding post E109, or

(3) internal frequency voltage supplied from the low impedance cathode of the 2nd vertical d-c amplifier (V103 and V104), through decoupling resistor, R127.

The grid of the sync. amplifier, V109A, is returned to the junction of R163 and R164 through resistor R162 to provide sufficient bias for operation of the amplifier.

An analysis of the circuits between the plate of V109A and ground will show that with a signal applied to the control grid, the high end of the LOCKING control, R166, will be electrically receiving signals developed at the plate of this tube; and the low end of the LOCKING control will be receiving signals from the cathode. When this control is at approximately the center of its rotation, there is no signal since the center of the control is grounded. If this control is operated toward the plate side of R166, a locking voltage would be obtained which would be out of phase with the signal applied to the grid and consequently, tend to lock the sweep circuit oscillator at a polarity with respect to the negative peaks of the synchronizing signal. If the LOCKING control is advanced toward the cathode side of R166, the locking voltage applied to the sweep circuit oscillator would be in positive phase relation to the synchronizing signal. As a result of this circuit, the sweep circuit oscillator may be locked in with respect to incoming synchronizing signals, either in phase or out of phase with these voltages.

E. INTENSITY MODULATION AMPLIFIER

In cathode ray oscilloscope nomenclature a modulation of the intensity of the cathode ray tube beam is known as Z AXIS modulation. Such modulation is often useful to establish a time base for the horizontal deflection of the cathode ray tube beam. As an example, the beam might be modulated by a 1000 cycle source which would cause it to increase in brilliance and decrease each one-thousandth of a second, or each one-thousand microseconds. With this intensity modulation superimposed upon an observed wave form its duration could be calculated.

One-half of a type 12AT7 tube V109B, is utilized as an amplifier to provide intensity modulation for the cathode ray tube beam. Voltages to actuate this amplifier may be taken from the Z AXIS input, or by means of a jumper on the rear terminal board E110, pulses may be taken from the sweep circuit oscillator to provide beam blanking during the return trace when using the sweep circuit oscillator for horizontal deflection. If the voltage is taken from the Z AXIS input, it is applied to grid, pin 2, of V109A through capacitor C120. However, if the pulses from the sweep circuit oscillator are used for internal beam blanking, the signal is directly coupled to the grid from the cathode of the sweep circuit oscillator to eliminate low frequency discrimination. Resistor, R178, acts as a grid return to ground. Bias for this amplifier is provided in the cathode circuit by resistor, R177, shunted by capacitor, C133. This resistor-capacitor

combination provides compensation for improving the high frequency response of this amplifier. The B+ is supplied to the plate through resistor R176, and the output is taken from the plate through capacitor C134 and applied directly to the control grid of the cathode ray tube, V111. Positive voltages applied to the Z AXIS input will cause blanking action of the cathode ray tube beam.

F. CATHODE RAY TUBE

A type 3RP1 cathode ray tube, V111, is used as the indicating medium in the oscilloscope. This tube utilizes electrostatic deflection and has four free deflecting plates. Voltage for the operation of this tube is obtained from the high voltage section of the power supply, the negative side of which is filtered and applied through R181 to the control grid, pin 2, of V111. Intensity (INT.) control, R182, is connected directly from the negative side of the high voltage power supply to R184, the FOCUS control . Cathode, pin 3, of V111 is connected to the center arm of INTENSITY control R182 through resistor R183. As the INT. control is operated, it varies the potential difference between the cathode of V111 and the control grid, thereby controlling the intensity of the beam. FOCUS control, R184, is returned to ground through R185 and serves to focus the cathode ray tube beam. Anode #2 and grid #2, pin 8 of V111, are supplied with B+ from the center arm of the Astigmatism control, R179, in series with R180. The voltage at the output of this control determines the astigmatic focus and is designed to be equal to the nominal DC voltage of the deflection plates, pins 6, 7, 9, and 10 of V111.

The horizontal deflection plates, pins 9 and 10, are directly connected to terminal board E110. When the jumpers on this terminal board are arranged for internal connection, the output leads from the horizontal amplifier are connected directly to the deflection plates. When the jumpers are arranged for external connection, the output leads from the horizontal amplifier are connected to the deflection plates through resistors R188 and R189. These resistors provide the DC voltage and centering that was present with the internal connection; however, no signal is carried to the deflection plates. With this connection, an external signal may be applied to the deflection plates through capacitors C137 and C138 by connecting the external signal to the terminals marked EXT. INPUT. If it is desired to use an external capacitor to couple the signal directly to the deflection plates, this capacitor may be connected to the terminals marked D1 and D2 on the terminal board E110.

The vertical deflection plates, pins 6 and 7, are directly connected to the output of the vertical amplifier, however, the circuit can be modified as indicated by the dotted lines on the schematic diagram to allow for direct connection to the vertical deflection plates through terminal board E110 as described above for the horizontal deflection plates.

G. POWER SUPPLY

All voltages for operation of the oscilloscope are obtained from the power supply utilizing transformer T101. The primary of this transformer is connected to the permanent AC power cable W103. Fuses F101 and F102 are used between the input and the primary. The POWER OFF-ON switch, S105, is connected in series with one fuse and one side of the primary. There are basically four secondary windings on the transformer. One of these is center-tapped to ground and provides two full-wave voltages, approximately 90 and 325 volts, on each side of the center tap. The 325 volt winding is connected to the plates, pins 1 and 6, of the intermediate voltage rectifier, V110. The output is taken from cathode pin 7 of this rectifier and suitably filtered by means of capacitors C141B and C141C in conjunction with resistor, R198, to provide B+ voltage for the final stages and cathode follower of the horizontal amplifier. This output is also decoupled by means of resistors R196 and R197 and capacitor C141A and acts to supply the B+ voltage for the final stage and cathode follower of the vertical amplifier. The B+ voltage for the sync. amplifier is provided by the decoupling network consisting of R195 and C140D.

The 90 volt winding is connected to the plates of CR101 and CR102 through protective resistors R190 and R191. The output from these selenium rectifiers is filtered by C140A, C140B, and C140C in conjunction with R193 and R194 to provide low voltage B+ supply for the first push-pull vertical and horizontal amplifier stages respectively.

Another secondary winding has its low voltage side tied to one side of the 325 volt winding and its high voltage side tied to the cathode of selenium rectifier CR103. The output from this rectifier is filtered by C139A and C139B in conjunction with R192 and provides a high negative voltage for operation of the cathode ray tube.

A separate 6.3 volt winding is used to supply the heater of the cathode ray tube, V111. Another 6.3 volt winding, center-tapped to ground, is used to supply the heaters of all other tubes in the equipment.

SECTION 3

OPERATION

1. FUNCTION OF EQUIPMENT

Since Oscilloscope 385 is operated in a conventional manner, only a basic knowledge of cathode ray oscilloscopes is required for its application and operation. Therefore, this section will be concerned with the specific controls of the equipment and their functions.

2. CONTROLS AND THEIR FUNCTIONS

A. INT.-OFF (R182, S105): Operating the intensity control clockwise turns the power on to the instrument and the pilot light, E110, will indicate that the instrument is on. As this control is operated further clockwise, it controls the intensity of the pattern on the cathode ray tube. When moved to full clockwise position, the pattern is at maximum brilliancy.

B. FOCUS (R184): This control adjusts the focus, or sharpness, of the trace on the cathode ray tube.

C. POS. (LEFT-RIGHT (R152), DOWN-UP (R119): The purpose of the positioning controls is to adjust the position of the trace on the screen, either horizontally, or vertically.

D. VERT. ATTEN. (S101):

IMPORTANT NOTE

Always operate the VERT. ATTEN. switch to the highest attenuator position in which suitable vertical deflection can be obtained. If this is not done, overloading of the cathode follower will generally result. Overloading can be detected by a clipping or squashing of the pattern.

This control attenuates the signal fed in at the vertical input connector by a factor of 1, 10 or 100. Positive DC voltages will cause the beam to move up on the screen.

When turned to the CAL position, this control permits a line frequency calibration voltage of 0.5 volts peak-to-peak to be applied to the vertical amplifier for use in calibrating the gain of the amplifier.

E. VERT. GAIN (R116): This control is used as a vernier in connection with the VERT. ATTEN. to control the height of the pattern on the screen in the case of AC voltages; and in the case of DC voltages, the extent of deflection, either up or down, of the beam.

F. VERT. D.C. BAL. (R111): This control is used to balance the D.C. voltages at the output of the vertical cathode followers so there is no vertical shift in beam positioning with the operation of the VERT. GAIN control.

G. HOR. ATTEN. (S102):

IMPORTANT NOTE

Always operate the HOR. ATTEN. switch to the highest attenuator position in which suitable horizontal deflection can be obtained. If this is not done, overloading of the cathode follower will generally result. Overloading can be detected by a clipping or squashing of the pattern.

This control attenuates the signal fed in at the horizontal input connector by a factor of 1, 10 and 100. Positive DC voltages will cause the beam to move to the right on the screen. This control, when turned to the "SWEEP" position, permits the sawtooth from the sweep circuit oscillator to be amplified by the horizontal amplifier, thus providing horizontal deflection

When turned to the CAL position, this control permits a line frequency calibration voltage of 0.5 volts peak-to-peak to be applied to the horizontal amplifier for use in calibrating the gain of the amplifier.

H. HOR. GAIN (R146): This control is used as a vernier in connection with the HOR. ATTEN. to control the width of the pattern on the screen in the case of external AC voltages; and in the case of DC voltages, the extent of deflection, either left or right, of the beam. When the HOR. ATTEN. is in the "SWEEP" position, the HOR. GAIN controls the width of the sweep.

I. HOR. D.C. BAL. (R145): This control is used to balance the D.C. voltages at the output of the horizontal cathode followers so there is no horizontal shift in beam with the operation of the horizontal GAIN control.

J. COARSE FREQUENCY (S104): This control selects the range of frequencies of the internal sweep circuit oscillator which may operate between the limits of 3 and 50,000 cycles. Although the frequency ranges are marked on the panel for convenience of the operator, these frequencies are only approximate and, in general, the actual frequency range will be much greater so that two consecutive frequency ranges will exhibit a sizeable overlap.

K. VERNIER-FREQUENCY (R172): This control serves as a vernier on the frequency being generated by the sweep circuit oscillator in any one of the six portions of the COARSE FREQUENCY control.

L. SYNC. SELECTOR (S103): This control selects synchronizing voltage for application to the sweep circuit oscillator. These synchronizing voltages may be selected either from an external source, internal source which is the voltages being applied to the vertical amplifiers, or from an internal source of line frequency voltage.

M. LOCKING (R166): This control permits selection of either positive or negative peaks of synchronizing voltages and, in addition, controls the extent of locking voltage applied to the sweep circuit oscillator.

N. TERMINALS:

(1) Vertical Input (AC) (E101): Input for AC voltages deflecting the beam vertically on the cathode ray tube screen.

(2) Vertical Input (DC) (E102): Input for DC voltages applied to the vertical amplifiers.

(3) Horizontal Input (AC) (E104): Input for AC voltages deflecting the beam horizontally on the cathode ray tube screen.

(4) Horizontal Input (DC) (E105): Input for DC voltages applied to the horizontal amplifiers.

(5) Gnd (2) (E103, E106): Direct connection to chassis of equipment and to one side of all other externally applied voltages.

(6) Ext. (E109): Input for external synchronizing voltages to be used in synchronizing the sweep circuit oscillator.

(7) Line (E107): A source of line supply frequency to be used either in causing deflection for horizontal or vertical inputs, or as a source of line frequency for any other use to which it might be put.

(8) Z Axis (E108): Connection for an external voltage to be used in intensity modulating the cathode ray tube beam.

(9) Terminal Board (E110): Permits direct connection to horizontal deflection plates and provides means of beam blanking from internal sweep circuit oscillator. As was outlined in the previous section, with a slight wiring modification this board will also permit direct connection to the vertical deflection plates.

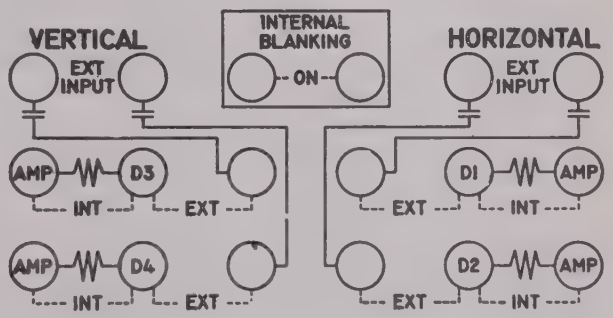

Figure 3-1. Rear Terminal Board E110

3. OPERATION

A. OBSERVING WAVE FORMS USING INTERNAL SWEEP AND SYNC.

Connect the source of alternating voltage to be observed to the vertical input (AC) and GND connections. Set the COARSE FREQUENCY control, S104, to the slowest sweep frequency position "3-18". The SYNC SELECTOR, S103 should be turned to "INT", while the LOCKING control R166, is turned to the zero position. Adjust

VERT. GAIN, R116, and VERT. ATTEN., S101, for suitable vertical deflection. Adjust HOR. GAIN, R146, until the pattern is of the desired width. When the pattern first appears, it will usually show many cycles as the picture of the sine wave under observation in Figure 3-2. Slowly rotate the VERNIER-FREQUENCY, R174, until the number of cycles decreases to the desired number. If the number is still greater than convenient, then COARSE FREQUENCY, S104, should be rotated to the next clockwise position and fewer cycles will appear as shown in Figure 3-3. When the desired number of cycles are obtained, the trace can be locked in by rotating the LOCKING control, R166, either clockwise or counterclockwise, depending upon whether it is desired to lock in positive or negative synchronizing pulses.

B. OBSERVING WAVE FORMS USING INTERNAL SWEEP AND EXT. SYNC.

Follow all steps outlined in paragraph 3 (A) with the following exception: SYNC. SELECTOR, S103, is turned to "EXT" rather than "INT", and the source of synchronizing voltage is applied between the EXT. binding post and GND.

C. OBSERVING WAVE FORMS USING INTERNAL SWEEP WITH LINE FREQUENCY SYNCHRONIZING VOLTAGES

Follow all steps outlined in paragraph 3 (A) with the following exception: When the sweep circuit is to be locked in at line frequency, SYNC. SELECTOR, S103, is turned to "LINE".

D. OBSERVING WAVE FORMS USING INTERNAL SINE WAVE LINE FREQUENCY SWEEP

Connect the source of alternating voltage to be observed between the vertical input and GND. Set the HOR. ATTEN., S102, to the CAL position. Operate the HOR. GAIN and VERT. GAIN controls to give the desired size of pattern. LOCKING, VERNIER-FREQUENCY and SYNC. SELECTOR controls have no effect upon the operation.

E. OBSERVING PATTERNS WITH SINE WAVE VOLTAGES IN BOTH HORIZONTAL AND VERTICAL INPUTS.

Connect the two voltages for comparison to the oscilloscope, one on the horizontal input and one on the vertical input. Adjust the HOR. ATTEN., S102, and VERT. ATTEN., S101, to the highest attenuation position that will give suitable deflection in both directions. Adjust the HOR. GAIN and VERT. GAIN controls until the pattern is of the desired size. With the above controls so adjusted, as the two frequencies become exact ratios of one another definite patterns, as illustrated in figures 3-4 and 3-5, will appear on the screen.

The rule for determining ratios is to count the number of times the pattern touches one axis and then the number of times it touches the other. The ratio between the two is the ratio of the two frequencies. If the beam touches the horizontal axis more often that the vertical axis, then the beam must be moving more slowly in the horizontal direction than it is in the vertical direction. This being the case, the slowest frequency is being fed into the horizontal amplifier.

F. APPLYING VOLTAGE DIRECTLY TO DEFLECTION PLATES (See Figure 3-3)

WARNING

The voltages that appear on the bottom two rows of terminals on TERMINAL BOARD E110 are by necessity high and dangerous to human life. Before changing any jumper connections on these terminals, de-energize the oscilloscope.

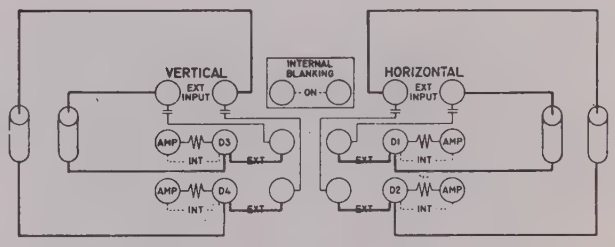

Figure 3-1A. Rear Terminal Board E-110, showing the addition of larger external capacitors

(1) Vertical Plates: If the vertical deflection plates are connected to the vertical amplifier through terminal board E110 as indicated by the dotted lines on the schematic diagram, this terminal board can be used for direct connection to the vertical deflection plates as outlined below.

To apply voltages directly to the vertical deflection plates, change the jumpers on the vertical side of the board from "INT" to "EXT" connection as indicated by the dotted lines on the diagram appear-

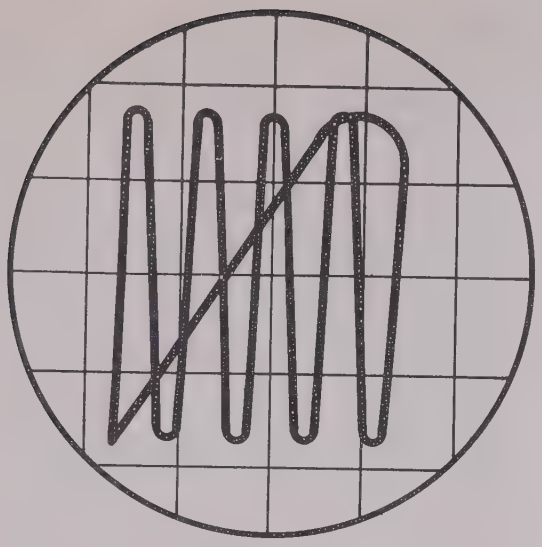

Figure 3-2

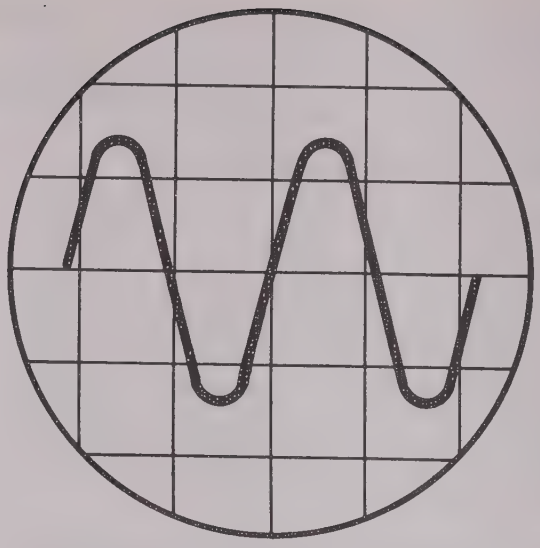

Figure 3-3

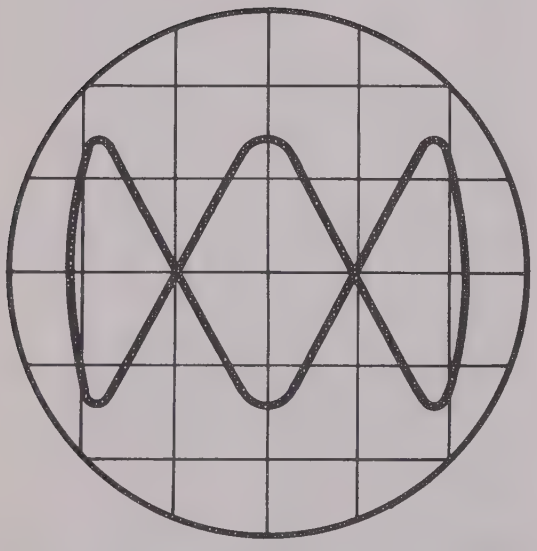

Figure 3-4

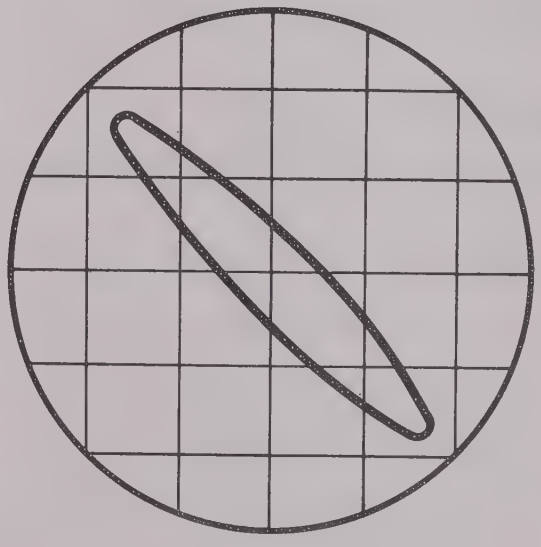

Figure 3-5

Wave Forms

ing on the cover of TERMINAL BOARD, E110. The deflecting voltages may then be applied to the two terminals marked "EXT. INPUT". These two terminals are isolated from the voltage on the deflection plates through capacitors C135 and C136. In observing very low frequency wave forms, the time constant of this input circuit may become objectionable. In this case, larger external capacitors may be connected between the terminals marked "EXT. INPUT" and the terminals marked D3 and D4 (See Figure 3-3A).

(2) Horizontal Plates: To apply voltages directly to the horizontal deflection plates, change the jumpers on the horizontal side of the board from "INT" to "EXT" connection as indicated by the dotted lines on the diagram appearing on the cover of TERMINAL BOARD E110. The deflecting voltages may then be applied to the two terminals marked "EXT. INPUT'. These terminals are isolated from the voltage on the deflection plates through capacitors C137 and C138. In observing very low frequency wave forms, the time

constant of this input circuit may become objectionable. In this case, larger external capacitors may be connected between the terminals marked "EXT. INPUT" and the terminals marked D1 and D2.

G. RETURN TRACE ELIMINATION

When using the sweep circuit oscillator for horizontal deflection, should it be desired to blank the beam out on the return trace, a jumper should be installed between the two INTERNAL BLANKING terminals on the TERMINAL BOARD E110. With these terminals connected together, voltage should not be fed in at the Z AXIS binding post E107, on the main panel to avoid distorting the sawtooth output of the sweep circuit oscillator.

H. OTHER APPLICATIONS OF THE OSCILLOSCOPE

In addition to using the 385 for observation of wave forms as outlined in paragraphs 3 (A) through 3 (G), the oscilloscope may find use in many other applications such as:

(1) Alignment of tuned R.F. and I.F. stages and video circuits.

(2) Alignment of F.M. discriminator stages.

(3) Observation of irregular wave shapes, pulses, etc.,

(4) Approximate measurements of percent distortion,

(5) Detection and identification of hum in power supplies, and

(6) Determination of percent modulation in transmitters.

(7) Due to the wide frequency response of the vertical amplifiers, being from zero cycles to 4 mc AC, the instrument will find extremely wide uses in connection with measurements and observation of wave froms from very low frequencies on up into the high frequency ranges.

(8) If use is made of the calibrating voltage, this instrument may be used as an electronic voltmeter. As an example, if it is desired to determine the voltage of an unknown signal being applied, the amplifier should first be calibrated by rotating the attenuator switch to the CAL. position and adjusting the gain control of the amplifier so that the calibration voltage of 0.5 volts peak-to-peak provides some convenient deflection such as 5 divisions (1/2 inch). Under these specific conditions, the amplifier would have a sensitivity of 1 volt peak-to-peak per inch or 0.1 volt peak-to-peak per division. The Attenuator should then be rotated until the signal being applied produces a convenient deflection. The attenuating factor can then be applied with the previously calibrated sensitivity to interpret the deflection of the applied signal in terms of voltage. For example, if the applied signal produced 7 divisions with the attenuator in the X10 position and the amplifier calibrated to 0.1 volts per division as outlined above, the voltage of the signal would be interpreted to be 7 x 0.1 x 10 = 7 volts peak-to-peak. This technique can be used to calibrate either the vertical or horizontal amplifiers.

If either the VERT. or HOR. GAIN controls are changed, recalibration should be effected unless notations of the exact control settings have been made and recorded for future use. Such recorded calibrations should be accurate for relatively long periods of time as they would be affected only by the operator's ability to reset accurately and the potential loss of mutual conductance with age of the amplifier tubes.

(9) In using the vertical amplifier with unshielded leads, caution should be taken as these unshielded leads might pick up stray fields and distort the wave shape being observed. Such precautions consist of using as short leads as possible and orienting the leads so that they do not come close to a source of AC fields such as transformers or alternating-current-carrying wires.

SECTION 4

MAINTENANCE

I. GENERAL

Components in oscilloscope 385 can, in general, be replaced with equivalent components without the necessity of any further adjustment except where specifically mentioned. Most of the components may be replaced in the scope generally serviced by merely removing the side panels; six captive screws per panel; however, it will be found much more convenient when attempting any major repair to remove the sub-assembly involved as indicated below.

A. REMOVING SUB-ASSEMBLIES

(1) Vertical Amplifier.

(a) Remove the right side panel.

(b) Unsolder the two leads from the vertical deflection plates in the rear of the scope. (Note the manner of connection and color code of wires as the reversal of these leads will reverse the polarity of the amplifier.)

(c) Remove the four screws holding the vertical amplifier assembly to the top of the chassis.

(d) Remove the assembly from the chassis by giving it a slight counter-clockwise turn and pulling straight out.

(e) The vertical amplifier assembly may then be swung down and laid on the bench next to the oscilloscope and the two leads from the amplifiers re-connected to the terminal board with short jumpers. The oscilloscope may now be operated in its normal manner with this circuit completely exposed.

(2) Horizontal Amplifier.

(a) Remove the left side panel.

(b) Unsolder the two leads from the horizontal amplifier assembly at terminal board E110 in the rear of the scope. (Note the manner of connection and color code of wires as the reversal of these leads will reverse the polarity of the amplifier.)

(c) Remove the four screws holding the horizontal amplifier panel to the top of the chassis.

(d) Remove the assembly from the chassis by giving it a slight clockwise turn and pulling straight out.

(e) The horizontal amplifier assembly may then be swung down and laid on the bench next to the oscilloscope and the two leads from the amplifiers re-connected to the terminal board with short jumpers. The oscilloscope may now be operated in its normal manner with this circuit completely exposed.

(3) Sweep Circuit Oscillator.

(a) Remove the left side panel.

(b) Remove the four screws holding the sweep circuit oscillator panel to the top of the chassis.

(c) Remove the assembly from the chassis by pulling straight out.

(d) The sweep circuit oscillator may then be swung down and laid on the bench beside the oscilloscope and the scope operated in the normal manner with this circuit completely exposed.

(4) Sync. Circuit.

(a) Remove the right side panel.

(b) Remove the four screws holding the sync. circuit panel to the top of the chassis.

(c) Remove the assembly from the chassis by applying a slight clock-wise twist and pulling straight out.

(d) The sync. circuit assembly may then be swung down and laid on the bench next to the scope and the scope operated in the normal manner with this circuit completely exposed.

(5) Power Supply.

(a) Disengage the bottom pan from the chassis by removing the four water-tight screws from the shock mounts.

(b) Remove both side panels.

(c) Unsolder the two gray wires at the pilot light assembly and the two wires coded white with blue tracers. One of these wires is terminated at the upper fuse post and the other on the AC switch located on the back of the INTENSITY control.

(d) Unsolder the shield of the power cord from its lug on the power supply assembly.

(e) Remove the four screws holding the power supply assembly to the chassis. Two of these screws are located on the front of the chassis and the other two on the bottom.

(f) The assembly may then be removed by pulling it through the opening on the right side of the chassis and turning it slightly counter-clockwise. There is sufficient slack in the cable to permit this removal

(g) After reconnecting the two wires coded white with blue tracers, and the two gray wires from the pilot light assembly by means of jumpers, the oscilloscope may be operated in the normal manner with this assembly completely exposed.

IMPORTANT NOTE

IN CASE OF EMERGENCY, WHEN REPLACEMENT PARTS ARE NOT AVAILABLE, THESE ASSEMBLIES MAY BE COMPLETELY DETACHED FROM THE OSCILLOSCOPE BY UNSOLDERING THE CABLES FROM DISTRIBUTION BOARD AND A CONSOLIDATION OF WORKABLE ASSEMBLIES MAY BE ACCOMPLISHED SINCE EACH ASSEMBLY IS INTERCHANGEABLE FROM ONE OSCILLOSCOPE TO ANOTHER.

B. REPLACING CATHODE RAY TUBE

CAUTION

HANDLE WITH CARE. Breakage of this tube, which contains a high vacuum, may result in injury from flying glass. Do not strike or scratch the tube. Never subject to more than moderate pressure when installing in or removing from equipment.

Should it be necessary to replace the cathode ray tube, the following procedure should be followed:

(1) Remove the right side panel.

(2) Loosen the cathode ray tube clamp (See Figure 4-2).

(3) The cathode ray tube may then be removed by disengaging the socket and pulling forward and out with the tube visor.

C. REPLACING THE TRANSFORMER

Should it become necessary to replace the transformer, T101, the following procedure should be followed:

(1) Disengage the bottom pan from the chassis by removing the four water-tight screws from the shock mounts.

(2) Remove both side panels.

(3) Unsolder all leads from the transformer terminals, being sure to identify them so that they can be correctly replaced.

(4) Remove the cathode ray tube as outlined above.

(5) Remove the four screws securing the transformer to the main chassis. These screws are located on the bottom of the chassis.

(6) The transformer may then be removed through the right side of the chassis and the replacement made.

D. ADJUSTMENT OF DC AMPLIFIERS (HORIZONTAL AND VERTICAL)

The amplifiers used in the vertical and horizontal deflection circuits are of the direct-coupled type which depend upon proper adjustment for best operation. Although these adjustments are made in the factory, it is possible that after replacement of major components, readjustment may be required for optimum performance. Some of the symptoms of maladjustment and the methods for correcting them are listed below.

(1) Lack of Sensitivity, Insufficient Positioning, Crowding, or Poor Focus (Astigmatic Condition): If any one or more of these conditions exist in the vertical or horizontal amplifiers, readjustment of BIAS controls R125 and R155 respectively would be advisable. For the vertical amplifier, adjust BIAS ADJ. R125 until the voltage drop across plate load resistor R130 or R131 is 45 volts with the beam vertically centered on the cathode ray tube. For the horizontal amplifier, BIAS ADJ., R155, should be adjusted until the voltage drop across plate load resistor R157 or R158 is 90 volts when the beam is horizontally centered on the cathode ray tube.

If, after the bias adjustment indicated above, the vertical amplifier still exhibits excessive crowding, readjustment of LINEARITY control, R129, would be advisable. Crowding is the term used for non-linearity of the pattern height with changes in positioning. For example, a one-half inch pattern obtained in the center of the screen may be appreciably less than one-half inch when positioned to the top or bottom of the screen. To readjust LINEARITY control R129, feed a test signal into the vertical amplifier and adjust the trace until it is approximately one-half inch high and positioned to the top or bottom of the cathode ray tube. Adjust R129 for equal deflection.

(2) Positioning Controls Incapable of Swinging the Beam Off Screen In One Direction: If replacement tubes used in the horizontal or vertical DC amplifiers are badly unbalanced, a condition might result in which the POSITIONING control is not capable of positioning the beam off screen in one direction. If this condition arises, the unbalanced tube should be replaced.

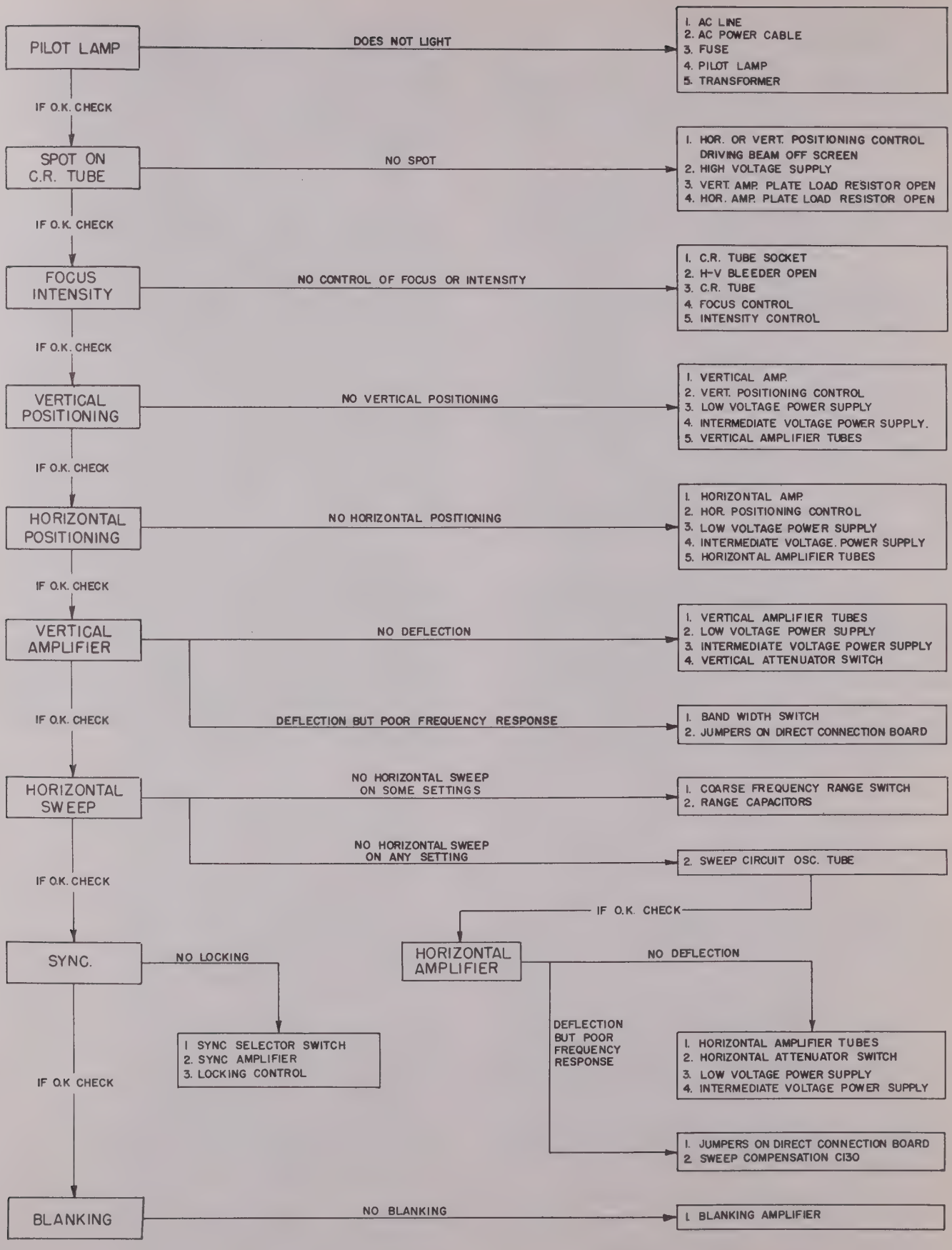

FIGURE 4-1. TROUBLE SHOOTING CHART

MODEL 385 PARTS LIST

NOTE: There is a minimum billing charge of $1.50 for any one parts order.

REF. SYMBOL	HICKOK CODE NO.	PART AND DESCRIPTION	FUNCTION
	2490-253	BOOKLET, instructions	
	3030-56	CABLE ASSEMBLY	
C101	3105-207	CAPACITOR: .1 mfd., 600 V., GMV	
C102	3115-10	CAPACITOR: 3-12 mmf., trimmer, ceramic	
C103	3110-31	CAPACITOR: 100 mmf., 500 VDCW, ±10%	
C104	3115-10	CAPACITOR: Same as C102	
C105	3110-28	CAPACITOR: 1,000 mmf., 500 VDCW, ±20%	
C106	3110-7	CAPACITOR: .005 mfd., -0 +100%, disk type, ceramic	
C107	3115-1	CAPACITOR: 3-12 mmf., trimmer, ceramic	
C108	3115-2	CAPACITOR: 7-35 mmf., trimmer	
C109	3115-2	CAPACITOR: Same as C108	
C110	3115-7	CAPACITOR: 1.5-3 mmf., trimmer, ceramic, zero temp. coeff.	
C111	3116-1	CAPACITOR: 1.5 mmf., 500 VDC, 20%, fixed, comp.	
C112	3105-207	CAPACITOR: Same as C101	
C113	3110-28	CAPACITOR: Same as C105	
C114	3115-10	CAPACITOR: Same as C102	
C115	3110-31	CAPACITOR: Same as C104	
C116	3115-10	CAPACITOR: Same as C102	
C117	3110-28	CAPACITOR: Same as C105	
C118	3110-7	CAPACITOR: Same as C106	
C119	3115-1	CAPACITOR: Same as C107	
C120	3105-113	CAPACITOR: .15 mfd., 200 V., 10%, paper	
C121	3105-113	CAPACITOR: Same as C120	
C122	3105-113	CAPACITOR: Same as C120	
C123	3105-112	CAPACITOR: .5 mfd., 200 V., 10%, paper	
C124	3105-113	CAPACITOR: Same as C120	
C125	3105-157	CAPACITOR: .03 mfd., 200 V., 10%, paper, metallized	
C126	3110-28	CAPACITOR: 5000 mmf., 500 VDCW, ±20%, ceramic	
C127	3110-28	CAPACITOR: Same as C105	
C128	3110-30	CAPACITOR: 150 mmf., 500 VDCW, ±10%, ceramic	
C129	3110-27	CAPACITOR: 50 mmf., 500 VDCW, ±10% ceramic	
C130	3115-11	CAPACITOR: 70-90 mmf., 500 VDCW, trimmer	
C131	3095-27	CAPACITOR: 47 mmf., 500 V., 10%, mica	
C132	3105-112	CAPACITOR: Same as C123	
C133	3110-29	CAPACITOR: 2,000 mmf., 500 VDCW, ±20%, ceramic	
C134	3110-33	CAPACITOR: .1 mfd., 600 V., GMV	
C135	3105-135	CAPACITOR: .1 mfd., 400 V., ±20%, paper	
C136	3105-135	CAPACITOR: Same as C135	
C137	3105-135	CAPACITOR: Same as C135	
C138	3105-135	CAPACITOR: Same as C135	
C139A & B	3105-124	CAPACITOR: 2 Section, each section 500,000 mmf., 1000 VDCW, +20%, -10%, paper	
C140A	3085-55	CAPACITOR: Electrolytic, 20-20-20-20 mfd., 150 V., oper. temp. range -20° C to +85° C.	
C140B	3085-55	CAPACITOR: In same unit with C140A	
C140C	3085-55	CAPACITOR: In same unit with C140A	
C140D	3085-55	CAPACITOR: In same unit with C140A	
C141A	3085-56	CAPACITOR: Electrolytic, 20-20-20 mfd., 450 V., oper. temp. range -20° C to +85° C.	
C141B	3085-56	CAPACITOR: In same unit with C141A	
C141C	3085-56	CAPACITOR: In same unit with C141A	
L101	3250-68	CHOKE: 15 microhenrys	
L102	3250-67	CHOKE: 38 microhenrys	
F101	6900-6	FUSE: 3/4 amp Slo-Blo, 3AG, tubular	
F102	6900-6	FUSE: Same as F101	
E110	12270-12	LAMP: G. E., .15 amp, miniature bayonet base	
	12450-95	LEAD Ass'y., Ground	

MODEL 385 PARTS LIST

NOTE: There is a minimum billing charge of $1.50 for any one parts order.

REF. SYMBOL	HICKOK CODE NO.	PART AND DESCRIPTION	FUNCTION
CR101	18150-18	RECTIFIER: Selenium, Max, input 130 V RMS, 20 MA output current	
CR102	18150-18	RECTIFIER: Same as CR101	
CR103	18150-22	RECTIFIER: Selenium	
R101	18415-222	RESISTOR: 2.2 meg., 10%, 1/2 W, fixed, comp.	
R102	18415-222	RESISTOR: Same as R101	
R103	18414-222	RESISTOR: 220,000 ohms, 10%, 1/2 W, fixed, comp.	
R105	18413-222	RESISTOR: 22,000 ohms, 10%, 1/2 W, fixed, comp.	
R106	16925-207	POTENTIOMETER: 500 ohms, 20%, standard linear, "A" taper	
R107	18410-472	RESISTOR: 47 ohms, 10%, 1/2 W, fixed, comp.	
R108	18411-182	RESISTOR: 180 ohms, 10%, 1/2 W, fixed, comp.	
R109	18412-222	RESISTOR: 2200 ohms, 10%, 1/2 W, fixed, comp.	
R110	18412-222	RESISTOR: Same as R109	
R111	16925-208	POTENTIOMETER: 1000 ohms, linear, carbon	
R112	18410-152	RESISTOR: 15 ohms, 10%, 1/2 W, fixed, comp.	
R113	18410-472	RESISTOR: Same as R107	
R114	18410-472	RESISTOR: Same as R107	
R115	18410-472	RESISTOR: Same as R107	
R116	16925-209	POTENTIOMETER: 5,000 ohms, ±20%, taper	
R117	18412-122	RESISTOR: 1,200 ohms, 10%, 1/2 W, fixed, comp.	
R118	18413-122	RESISTOR: Same as R117	
R119	16925-167	POTENTIOMETER: 500 ohms, 20%, linear, taper	
R120	18411-101	RESISTOR: 100 ohms, 5%, 1 W, fixed, comp.	
R121	18412-271	RESISTOR: 2,700 ohms, 5%, 1/2 W, fixed, comp.	
R122	18412-271	RESISTOR: Same as R121	
R123	18410-472	RESISTOR: Same as R107	
R124	18410-472	RESISTOR: Same as R107	
R125	16925-158	POTENTIOMETER: 1,000 ohms, linear, wirewound	
R126	18432-222	RESISTOR: 2,200 ohms, 10%, 2 W, fixed, comp.	
R127	18413-102	RESISTOR: 10,000 ohms, 10%, 1/2 W, fixed, comp.	
R128	18433-152	RESISTOR: 15,000 ohms, 10%, 2 W, fixed, comp.	
R129	16925-205	POTENTIOMETER: 25,000 ohms	
R130	18432-361	RESISTOR: 3,600 ohms, 5%, 2 W, fixed, comp.	
R131	18432-361	RESISTOR: Same as R130	
R132	18411-271	RESISTOR: 270 ohms, 5%, 1/2 W, fixed, comp.	
R133	18411-271	RESISTOR: Same as R132	
R134	18414-222	RESISTOR: Same as R103	
R135	18415-222	RESISTOR: Same as R101	
R136	18415-222	RESISTOR: Same as R101	
R137	18414-222	RESISTOR: Same as R103	
R138	18415-222	RESISTOR: Same as R101	
R139	18413-222	RESISTOR: Same as R105	
R140	18410-472	RESISTOR: Same as R107	
R141	18413-102	RESISTOR: Same as R127	
R142	18410-472	RESISTOR: Same as R107	
R143	18412-271	RESISTOR: Same as R121	
R144	18412-271	RESISTOR: Same as R121	
R145	16925-208	POTENTIOMETER: Same as R111	
R146	16925-209	POTENTIOMETER: Same as R116	
R147	18410-472	RESISTOR: Same as R107	
R148	18410-472	RESISTOR: Same as R107	
R149	18412-122	RESISTOR: Same as R117	
R150	18412-682	RESISTOR: 6,800 ohms, 10%, 1/2 W, fixed, comp.	
R151	18412-682	RESISTOR: Same as R150	
R152	16925-204	POTENTIOMETER: 10,000 ohms,20%, linear, taper	
R153	18410-472	RESISTOR: Same as R107	

MODEL 385 PARTS LIST

NOTE: There is a minimum billing charge of $1.50 for any one parts order.

REF. SYMBOL	HICKOK CODE NO.	PART AND DESCRIPTION	FUNCTION
R154	18410-472	RESISTOR: Same as R107	
R155	16925-158	POTENTIOMETER: Same as R125	
R156	18432-361	RESISTOR: Same as R130	
R157	18433-121	RESISTOR: 12,000 ohms, 5%, 2 W, fixed, comp.	
R158	18433-121	RESISTOR: Same as R157	
R160	18414-102	RESISTOR: 100,000 ohms, 10%, 1/2 W, fixed, comp.	
R161	18413-222	RESISTOR: 15,000 ohms, 10%, 1/2 W, fixed, comp.	
R162	18415-102	RESISTOR: 1 meg., 10%, 1/2 W, fixed, comp.	
R163	18413-152	RESISTOR: Same as R161	
R164	18412-472	RESISTOR: 4,700 ohms, 10%, 1/2 W, fixed, comp.	
R165	18413-472	RESISTOR: 47,000 ohms, 10%, 1/2 W, fixed, comp.	
R166	16925-166	POTENTIOMETER: 500,000 ohms, 20%, linear, taper	
R167	18413-102	RESISTOR: Same as R127	
R168	18413-102	RESISTOR: Same as R127	
R169	18411-472	RESISTOR: 470 ohms, 10%, 1/2 W, fixed, comp.	
R170	18411-222	RESISTOR: 220 ohms, 10%, 1/2 W, fixed, comp.	
R171	18414-102	RESISTOR: Same as R160	
R172A	16925-162	POTENTIOMETER: 5 meg., ±20%, dual, linear, carbon	
R172B	16925-162	POTENTIOMETER: 1 meg., ±20%, dual, linear, carbon	
R173	18414-222	RESISTOR: Same as R103	
R174	18414-332	RESISTOR: 330,000 ohms, 10%, 1/2 W, fixed, comp.	
R175	18415-222	RESISTOR: Same as R101	
R176	18413-102	RESISTOR: Same as R127	
R177	18411-472	RESISTOR: Same as R169	
R178	18415-102	RESISTOR: Same as R162	
R179	16925-206	POTENTIOMETER: 100,000 ohms, 20%, linear, "A" taper	
R180	18414-472	RESISTOR: 470,000 ohms, 10%, 1/2 W, fixed, comp.	
R181	18415-152	RESISTOR: 1.5 meg., 10%, 1/2 W, fixed, comp.	
R182	16925-165	POTENTIOMETER: 250,000 ohms, ±20%, with switch	
R183	18414-152	RESISTOR: 150,000 ohms, 10%, 1/2 W, fixed, comp.	
R184	16925-164	POTENTIOMETER: 500,000 ohms, ±20%, linear	
R185	18424-751	RESISTOR: 750,000 ohms, 5%, 1 W, fixed, comp.	
R186	18415-472	RESISTOR: 4.7 meg., 10%, 1/2 W, fixed, comp.	
R187	18415-472	RESISTOR: Same as R186	
R188	18415-472	RESISTOR: Same as R186	
R189	18415-472	RESISTOR: Same as R186	
R190	18410-222	RESISTOR: 22 ohms, 10%, 1/2 W, fixed, comp.	
R191	18410-222	RESISTOR: Same as R190	
R192	18414-152	RESISTOR: Same as R183	
R193	18432-222	RESISTOR: Same as R126	
R194	18432-222	RESISTOR: Same as R126	
R195	18414-152	RESISTOR: Same as R183	
R196	18432-332	RESISTOR: 3,300 ohms, 10%, 2 W, fixed, comp.	
R197	18432-332	RESISTOR: Same as R196	
R198	18432-102	RESISTOR: 1,000 ohms, 10%, 2 W, fixed, comp.	
R199	18412-562	RESISTOR: 5,600 ohms, 10%, 1/2 W, fixed, comp.	
	19020-10	SCREEN: CR tube, celluloid	
S101	19912-281	SWITCH: Rotary, 4 pos., 1 sec., 2 pole	VERT. ATTEN.
S102	19912-282	SWITCH: Rotary, 5 pos., 2 pole	HORIZ. ATTEN.
S103	19912-240	SWITCH: Rotary, 3 pos., 1 pole	SYNC. SELECTOR
S104	19912-295	SWITCH; Rotary, 6 pos., 4 pole	COARSE FREQUENCY SELECTOR
S105		SWITCH: On back of R182	POWER OFF-ON
S106	19911-52	SWITCH: Toggle, single pole, 2 circuit	BANDWIDTH

MODEL 385 PARTS LIST

NOTE: There is a minimum billing charge of $1.50 for any one parts order.

REF. SYMBOL	HICKOK CODE NO.	PART AND DESCRIPTION	FUNCTION
T101	20800-120	TRANSFORMER	POWER
V101A & B	20875-77	TUBE: 12AT7	
V102A & B	20875-77	TUBE: Same as V101A & B	
V103	20875-92	TUBE: 6AH6	
V104	20875-92	TUBE: Same as V103	
V105A & B	20875-77	TUBE: Same as V101A & B	
V106A & B	20875-77	TUBE: Same as V101A & B	
V107A & B	20875-71	TUBE: 6J6	
V108A & B	20875-77	TUBE: Same as V107A & B	
V109A	20875-77	TUBE: Same as V101A	
V110	20875-68	TUBE: 6X4	
V111	20875-79	TUBE: 3RP1	C. R. Tub

In ordering parts or materials for this instrument, the serial number must first be given in order to identify properly the material required. Prices will be furnished upon request.